

distribution of the various Building-stones in the New-York-State are described at pages 9-24; and descriptive notes of these materials, the quarry-districts, and the quarries follow (pp. 25-143). Some statistics of the quarries and their products are given at pp. 145 and 146; and a useful index follows. The author supplies careful notes on the size of the quarries, the date of opening, the possessor, and the buildings constructed of the several kinds of stone; also particulars as to the dip of the strata, direction of joints and cleavage, petrography, water in the stone, the size of obtainable blocks, and the machinery employed in raising them. This memoir has been the work of an industrious and conscientious observer, who acknowledges the kind help of numerous owners, managers, and superintendents of quarries, and refers to specimens of the rocks, illustrating their nature and economic value, that have been deposited in the New-York-State Museum at Albany.

MISCELLANEOUS.

Note on the Sense of Direction in a European Ant (Formica rufa).
By Dr. HENRY C. McCook.

THE author remarked that during the summer of 1887 he had made an observation upon the well-known "horse-ant," or *Formica rufa*, of Great Britain. While visiting the Trosachs of Scotland he found a number of nests of this species scattered throughout the glen known as the Pass of Achray, through which flows the little Achray River, "the stream that joins Loch Katrine to Achray." These nests are found on either side of the foot-walk which leads from the Trosachs glen to the "sluices," as they are popularly called, which regulate the stage of water in Loch Katrine.

1. *Structure of the Ant-hills.*—The mounds raised by the rufous ants are heaps of earth intermingled with chippage of various sorts; they rise to the height of about three feet, and some of them are six or seven feet in diameter across the base. They stand amid the tall bracken which overhangs them, and at times almost conceals them from the passer-by. The surface of the mounds is covered with bits of straw and leaves, stalks of grass and ferns, and various material of like sort which forms a quite decided thatch. Numbers of openings appear upon the surface at irregular intervals from the summit to the base, and in the afternoon at 4 o'clock the workers in vast numbers were dragging the chippage back and forth, apparently engaged in closing the doors for the night, although time did not permit an observation of the actual closure.

2. *Character of Roads and Engineering Skill.*—That which especially attracted Dr. McCook's attention was the character of the roads leading from the ant-hills to the various points in the sur-

rounding woods. These roads or trails were distinctly marked upon the surface of the ground, having in places a width of from two to four inches which was stained a dark brown or black, probably by the formic acid exuded from the insects; the leaves and grass upon which the trail was made were pressed down and smoothed by the constant action of innumerable legs upon the surface. So well marked were the trails that even without the presence of the columns of insects that thronged back and forth upon them they were distinctly and easily traced. While following up one of these roads the observer was impressed by the fact that it showed scarcely any deviation from a straight line. In order to test this matter more carefully, he selected a large mound from which three roads radiated. These were all traced to their termination at three several oak-trees, up which the columns of ants ascended in search of food-supply from numerous aphides which infested the branches of the trees. The ant-roads were then carefully marked out by stakes stationed at short intervals, a course which was made necessary by the fact that they were carried for considerable distances beneath the tall bracken, which had to be pushed aside in order to reveal them. The result of his observations is as follows:—

Road no. 1 was twenty-one paces in length (about 65 feet) and was carried in an almost perfectly straight line from the nest to the terminal tree. No. 2 was twenty-three paces in length (about 70 feet). It varied less than 3 inches from a direct line measuring from the nest to a point within 2 feet of the terminal tree. There the column made a detour of about 6 inches from the straight line; but an abandoned path, continuous with the main road, which had apparently been used at a recent date, was traced for a considerable distance further without any deflection. No. 3 was the longest road of the three, being thirty-four paces in length. It extended for six paces in a straight line from the nest, at which point it touched an old stump, which evidently deflected the path at a slight angle. From this point it was again continued in a nearly straight line as far as the beaten foot-path through the wood. Here the ant-trail was obliterated by the friction of passing human feet, but the ants themselves thronged over the pathway in a column much broadened by continual interference and loss caused by foot passers. The trail was, however, resumed at a point nearly opposite that at which it touched the path, and was continued again in a straight line six paces further to the tree, where it terminated. When the entire trail was staked off it was found that its terminus deviated less than 3 feet from a straight line drawn from the point of departure at the ant-hill. The greater deviation in this case seemed evidently to have been caused by the peculiar difficulties in the chosen track. The three roads so radiated from the nest that they were included within about one quadrant of a circle, of which the two shorter trails might represent the radial boundaries of the quadrant, while the longer trail was drawn nearly midway between the two.

Taking the results of the three observations together it is mani-

fest that the ants showed an accurate sense of direction in marking out and following their approaches to the trees. It would be scarcely reasonable to attribute such mathematical accuracy as above shown to mere accident. The roads in point of directness were as accurately laid down as ordinary roads made by the engineering skill of men. The skill of the ants was all the more apparent from the fact that their paths were carried through the jungle of bracken and various other wood-plants. The same fact appears to indicate that the insects could not have been largely directed by the sense of sight*. It would perhaps be idle to speculate upon the manner in which this feat of emmet-engineering was accomplished, as there were no facts observed which give a clue to the mode of proceeding; but the problem is one well worth study by naturalists on the ground.

3. *Engineering of Texas Cutting-Ants.*—The author in this connexion alluded to an observation which has heretofore been placed on record † describing an underground route of the cutting-ant of Texas (*Atta fervens*). This route extended 448 feet, entirely beneath the surface of the earth, at some places as deep as 6 feet, and having an average depth of 18 inches. From the points at which the ants came to the surface the road was continued in a straight line 185 feet further to a tree in a gentleman's private grounds, which the ants were engaged in defoliating. The entire length of the roadway was thus 669 feet, and the path as laid out by a young engineer who assisted in the observation shows scarcely less deflection from a straight course than that of the rufous ants recorded in the above observation.

4. *Sentinels.*—The longest of the three trails alluded to made by the Scotch ants terminated upon an oak-tree, which was also occupied by a column of ants from a neighbouring hill. The two columns rigidly maintained their places on opposite sides of the trunk. Sentinels were scattered along either margin of both columns, and these exhibited great watchfulness and sensitiveness to the approach of any object. The author, on approaching his finger to these sentinels, observed that they seemed to perceive his finger when it reached a point an inch or an inch and a half distant from the bark. At once the ants thrust out their antennæ, extended their heads, then the two front legs, and finally the middle legs, thus hanging to the bark of the tree by the hind legs alone, the abdomen being slightly turned underneath the body, as though prepared to eject formic acid upon any adversary. In one case at least the ant hung to the bark by one hind foot alone, extending the whole body in a perpendicular direction from the surface of the tree. It presented a grotesque appearance, and exhibited every sign of eagerness and vigilance in the discharge of its duty as watchman.

* The vision of ants is probably limited within a very short distance from the eyes; under any circumstances, therefore, it could have but little influence in determining such a phenomenon as here recorded.—H. C. McC.

† See the author's 'Tenants of an Old Farm,' p. 264, fig. 90.

Several individuals were taken from one column and placed in the line of march of the ants from the other nest. They showed the usual evidences of strangeness and failed to fraternize; but, on the other hand, no one was assaulted by the passers by, a toleration worthy of note, as showing some degree of community among the various nests of the one species.

The time which the author could give to these observations was limited to several hours of a summer afternoon, which he spent as a tourist in this interesting mountain-region; but they present some conclusions which appear to be reasonably decisive, and which at least may serve to stimulate further observations in the same line extending over greater periods and including a greater number of cases.—*Proc. Acad. Nat. Sci. Philad.* November 1, 1887, p. 335.

On some new Species of Cepenina. By MM. A. GIARD and
J. BONNIER.

The Cepenina, or Epicarides parasitic upon the Brachyurous Decapods, until within the last few years were known only by a very small number of species which were very insufficiently described. Since the publication of our Monograph on *Cepen elegans*, with a revision of the group, we have received abundant materials for study, which enable us to extend considerably the notions arrived at with regard to these curious Isopoda.

Prof. Milne-Edwards has furnished us with a Cepenian parasitic upon the *Nautilograpsus minutus*, Fabr., of the Sargasso Sea. Prof. J. R. Henderson, of Madras, has sent us a *Portunicepon* parasitic upon the *Thalamita callianassa*, Herbst, of the Indian seas. Lastly, M. A. Agassiz, having been kind enough to confide to us for description the superb series of Epicarides belonging to the museum of Harvard College (Cambridge, Mass.), we have found in this collection a very interesting type, collected at the Society Islands upon *Trapezia dentifrons*, Latr.

The Cepen of the *Nautilograpsus*, which we shall call *Grapsicepon Edwardsi*, appears to be a comparatively abundant species. Of 326 *Nautilograpsi* collected on the 4th August, 1883 (voyage of the 'Talisman'), 32 bore parasites either on the right or on the left of the carapace, 2 were infested at the same time both to the right and left, and the two sexes are equally attacked by this *Cepen*.

This parasite produces no apparent deformation of the carapace of the *Nautilograpsus*. Nevertheless it is easy to recognize its presence in consequence of the transparency of the integuments of the crab, which enables us vaguely to distinguish the outlines of the Bopyrian. The reddish colour of the adult female of *Grapsicepon Edwardsi* persists very well in alcohol and greatly facilitates the search for it. The influence exerted upon the internal organs of the host seems to be very slight. A good number of infested females of the *Nautilograpsus* bear ova under the tail in as considerable quantities as the healthy females.